

Available online at www.sciencedirect.com**ScienceDirect**

Procedia Computer Science 87 (2016) 18 – 24

Procedia
Computer Science

2016 International Conference on Computational Science

Handwritten Marathi Compound Character Segmentation using Minutiae Detection Algorithm

Mrs. Snehal S. Golait^a, Dr. Latesh Malik^b^aResearch Scholar ,Department of CSE,

G.H.Raisoni College of Engineering,Nagpur

^b Professor &Head ,Department of computer Science & Engineering ,

G.H.Raisoni College of Engineering,Nagpur

Abstract

Segmentation process is the heart of handwritten Script Identification system. Aside from the large variation of individual's handwriting, many researchers found difficulty to separate characters from scanned word document Image. The key factor of selection of segmentation algorithm is used to improve efficiency of character segmentation as well as good feature extraction. One of the feature of Marathi script is Compound Character, derived from Devnagari, occur rarely in the script. Segmentation of such type characters is very difficult due to their complex structure. This paper proposed new technique for segmentation of handwritten Marathi compound characters. The Proposed algorithm used the concept of Minutiae extraction for fingerprint for segmenting the compound character. Basically Segmentation is carried out using morphological operations such as erosion and dilation. For segmenting the character from compound character our aim to find termination point and bifurcation points. And for finding the termination and bifurcation point proposed algorithm used the morphological operation hit or miss transform. The experimental results shows 90% accuracy in finding termination and bifurcation points.

© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the Organizing Committee of ICRTCSE 2016

Keywords: Erosion; Segmentation; bifurcation; Morphology;

E-mail address: snehal.golait@gmail.com

Devnagari script has 50 characters which can be written as individual symbols in a word. Devnagari Character recognition is complicated process due to presence of multiple conjuncts, loops, lower and upper modifiers and the number of disconnected and multistoried characters, in a word where all characters are connected through Shirrekha. OCR is further complicated by compound characters that make character separation and identification is very difficult.

OCR work on printed Devnagari Script started in early 1970's. Sinhala and Maharaja published presented a syntactic pattern analysis system with an embedded picture language for the recognition of handwritten and machine printed Devnagari characters. Vienna described Devnagari OCR in her doctoral Thesis. Performance of 93% accuracy at character level is reported after post processing. Pal and Chaudhuri reported a complete OCR system for printed Devnagari with 96% accuracy.

First research report on handwritten Devnagari characters was published in 1977. At present researchers have started to work on handwritten Devnagari characters and few research reports are published recently. Hanmandlu and Murthy proposed a Fuzzy model based recognition of handwritten Hindi numerals and characters and they obtained 92.67% accuracy for Handwritten Devnagari numerals and 90.65% accuracy for Handwritten Devnagari characters. Bajaj et al employed three different kinds of features namely, density features, moment features and descriptive component features for classification of Devnagari Numerals. They proposed multi-classifier connectionist architecture for increasing the recognition reliability and they obtained 89.6% accuracy for handwritten Devnagari numerals. Kumar and Singh proposed a Zernike moment feature based approach for Devnagari handwritten character recognition. They used an artificial neural network for classification. Sethi and Chatterjee proposed a decision tree based approach for recognition of constrained hand printed Devnagari characters using primitive features. Bhattacharya et al proposed a Multi- Layer Perceptron (MLP) neural network based classification approach for the recognition of Devnagari handwritten numerals and obtained 91.28% results. N. Sharma and U. Pal proposed a directional chain code features based quadratic classifier and obtained 80.36% accuracy for handwritten Devnagari characters and 98.86% accuracy for handwritten Devnagari numerals. Dr. Latesh Malik describes recognition of handwritten devnagari Characters with percentage component regular expression matching and classification tree and obtained 95% accuracy. U. pal and Sagarikadutta worked on piece-wise projection method for line segmentation of handwritten Bangla script obtained 99% accuracy and histogram method for word segmentation of handwritten Bangla script obtained 97.8% accuracy. Shubair Abdulla worked on Rotational Invariant Segment method for word segmentation of Arabic handwritten Script obtained 95.66% accuracy. Sushama Shelke worked on handwritten Marathi Compound Character Recognition using Structural feature extraction technique wavelet transform obtained 94.22 % accuracy.[1] As per related research no one is using the minutiae technique to segmenting character. This paper discussed the concept of minutiae used for segmenting Marathi character from handwritten Marathi compound character.

3. Proposed Method

The proposed algorithm used the concept of minutiae extraction for fingerprint for segmenting the compound character. The concept of minutiae is recognizing fingerprint based on local ridge features. Fingerprint identification is commonly employed in forensic science to aid criminal investigations etc. A fingerprint is a unique pattern of ridges and valleys on the surface of finger of an individual. A ridge is defined as a single curved segment, and a valley is the region between two adjacent ridges. Most automatic fingerprint recognition systems are based on local ridge features known as minutiae. There are about 150 different types of minutiae [5] categorized according to their configuration. Among these minutia types, "ridge ending" and "ridge bifurcation" are the most commonly used, since the other types of minutiae can be seen as combinations

of “ridge endings” and “ridge bifurcations”. Figure 2 illustrates the two most basic types of minutiae: ridge endings and bifurcations. These minutiae points are used for determining uniqueness of a fingerprint.



Figure 2: Ridge Ending and

Ridge Bifurcation

We analyzed the minutiae extraction for fingerprint recognition and used this concept for segmenting character from Marathi compound character. The flowchart for proposed algorithm is shown in the figure 3.

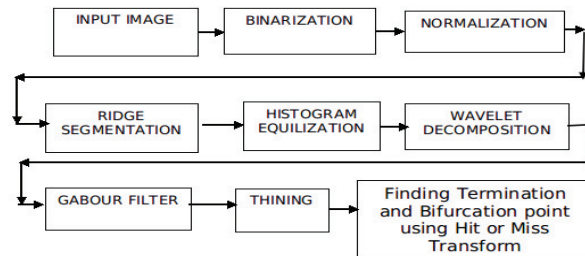


Figure 3: Block

Algorithm

Diagram of Proposed

Input Image

Input Image is scanned document using any flatbed scanner with resolution of minimum 300 dpi. The document may be scanned as color image or gray image or binary image.

Binarization

This is the first step in the processing of scanned image. In this process first digitization of Image is done. For binarization thresholding technique is used. Thresholding is an image processing technique for converting a gray scale or color image to a binary image based upon a threshold value.

Normalization

Normalization is one of the important pre-processing factors for character recognition. Normally, in normalization the character image is linearly mapped on to a standard plane by interpolation/extrapolation. The size and position of character is controlled such that the length and width of normalized plane are filled. By linear mapping, the character shape is not only deformed but also the aspect ratio changes.

Ridge Segmentation

The need of ridge segmentation is for finding the break points in character. In mathematics the ridges of a smooth function of two variables are a set of curves whose points are local maxima of the function in at least one dimension. This notion captures the intuition of geographical ridges. For a function of N variables, its ridges are a set of curves whose points are local maxima in N-1 dimensions. Correspondingly, the notion of valleys for a function can be defined by replacing the condition of a local maximum with the condition of a local minimum. The union of ridge sets and valley sets, together with a related set of points called the connector set form a connected set of curves that partition, intersect, or meet at the critical points of the function.

Histogram Equalization

Apply the Histogram equalization for adjusting image intensities to enhance contrast. In Matlab `histeq()` function is used to enhance the image.

Wavelet Decomposition

The wavelet decomposition is merely done for the lossless reduction of the size of an Image [11]. DWT decomposes the signal into mutually orthogonal set of wavelets. DWT decomposition is used for finding the

pixels at horizontal, vertical and in diagonal direction. In CWT, the wavelets are not orthogonal and the data obtained by this transform are highly correlated. The four values of the decomposition are shown in figure 4.

CA – Accurate Value, CD – Dimension value, CV – Vertical Value, CH – Horizontal Value

The four divisions in the image was the same in all level of the decomposition, instead the levels are the iteration. These four divisions of the decomposition levels have their own characteristics and preserved the values of the image. The values are

LL – Smoothing image of the original Image, LH - Preserves horizontal edge details

HL – Preserves vertical edge details, HH – Preserves diagonal edge

The original image is decomposed into many levels using the dwt function in the Matlab. The db1 wavelet is used as wavelet transforms and the four level decomposition has been carried out for the characters.

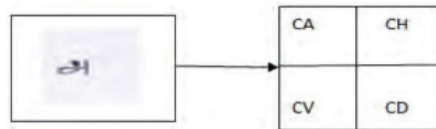


Figure 4:4 Level Wavelet

Decomposition

Gabor Filter

In the literature, there are several image noise removal methods which are applied in spatial, transform, or time-frequency domains. In the spatial domain a small mask is convolved with the image. This mask can be an averaging filter, a mean or Gaussian filter. In the transform domain, first the image is translated to the transform domain, then it is multiplied by a low pass filter and at the end by the inverse transformation, the enhanced image is obtained. In the transform domain, noise in the grey levels of an image contributes heavily to the high frequency components and the most of the image energy is concentrated in the low frequency components. Although, applying a low pass filter to a noisy image in the transform domain reduces the noise, at the same time it could eliminate some high frequency components that are not related to noise and weaken sharp transitions like edges. Furthermore, the transforms which perform on the whole image, do not take into account any spatial information where the frequency components come from. Therefore, noise reduction by low pass filtering in such domains does not preserve the local information of the image very well. Time-frequency transforms combine time-domain and frequency-domain analysis and allow obtaining a revealing picture of the temporal localization of the signal's spectral components. Due to this problem we consider the Gabor filter as a noise reduction technique.

Thinning

The next step is to thin the processed binary image using the morphological thinning operation. The thinning algorithm removes pixels from ridges until the ridges are one pixel wide.[5]. The thinning of an image I by a structuring element $J = (J_1, J_2)$ is given by

$$\text{Thin}(I, J) = I - (I \otimes J)$$

Finding termination and bifurcation point using Hit or Miss Transform.

After thinning we apply hit or Miss transform to find the termination and bifurcation points. Termination are those pixels in an image which have only one neighbor in a 3X3 neighborhoods. The terminations is given by applying Hit or Miss transform on I by J as follows:

$$M1 = (I \otimes J)$$

Where, I is the thinned image and J is the sequence of structuring element pairs (J_1, J_2)

$$I \otimes J = (I \otimes J_1) \cap (I \otimes J_2)$$

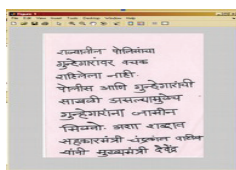
Ridge bifurcations are those pixels in an image which have only three neighbors in a 3X3 neighborhoods and these neighbors are not adjacent to each other. The minutiae image $M2$ containing ridge terminations is given by

$$M1 = (I \ominus J)$$

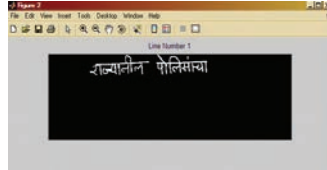
Where, I is the thinned image and J is the sequence of structuring element pairs(J_1, J_2)

$$I \ominus J = (I \ominus J_1) \cap (I \ominus J_2)$$

Experimental Results



(a)



(b)



(c)



(d)

a) Input Image b) Line Segmentation c) word Segmentation d) Output of Minutiae Detection algorithm.

5. Conclusion

In this paper we are proposed algorithm for segmentation of handwritten Marathi Compound Character using Minutiae concept. Using minutiae extraction algorithm and Hit or Miss transform able to get near about 90% accuracy for finding termination and bifurcation points. Experimental result shows best results in getting termination points and bifurcation. Using Minutiae extraction algorithm efficiency of Marathi character recognition is increased up to 95 %. This is the novel technique which is not used by any researcher.

Acknowledgements

This paper is made possible through the help and valuable support of my guide Dr.Latesh Malik. Finally, I sincerely thanks to my parents and God.

References

- [1]Sushama Shelke, Shaila Apte, "A Multistage Handwritten Marathi Compound Character Recognition Scheme using Neural Networks and Wavelet Features " International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 4, No. 1, March 2011.
- [2] Miss Vandana M. Ladwani, Dr.latesh Malik, "Novel Approach to Segmentation of Handwritten Devnagari Word", 978-0-7695-4246-1/10 \$26.00 © 2010 IEEE DOI 10.1109/ICETET.2010.143.
- [3]U.K.S. Jayarathna, G.E.M.D.C. Bandara, "A Junction Based Segmentation Algorithm for Offline Handwritten Connected Character Segmentation", International Conference on Computational Intelligence for Modeling Control and Automation, and International Conference on Intelligent Agents, Web Technologies and Internet Commerce (CIMCA-IAWTIC'06).
- [4] Ambadas B. Shinde, yogesh H. Dandawate, " Shirorekha Extraction in Character Segmentation for Printed Devanagari Text In Document Image Processing", 2014 Annual IEEE India Conference (INDICON).
- [5]Roli Bansal, Priti Sehgal & Punam Bedi, " Effective Morphological Extraction of True Fingerprint Minutiae based on the Hit or Miss Transform", International Journal of Biometrics and Bioinformatics(IJBB), Volume (4) : Issue (2).
- [6] Dhaval Salvi, Jun Zhou, Jarrell Waggoner, and Song Wang, " Handwritten Text Segmentation using Average Longest Path Algorithm", 978-1-4673-50542-95/132/\$31.00 ©20132 IEEE.
- [7] R.G. Casey et.al. "A Survey of Methods and Strategies in Character Segmentation", IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 18, pp 690-706, 1996.
- [8] Veena Bansal and R.M.K. Sinha. "Segmentation of touching and Fused Devnagari characters, ".Pattern recognition, vol. 35: 875-893, 2002.
- [9] Ms. Aarti Desai, Dr. Latesh Malik, " A Modified Approach to Thinning of Devanagari Characters", 978-1-4244-8679-3/11/\$26.00 ©2011 IEEE.

- [10] K.B.M.R. Batuwita, G.E.M.D.C. Bandara, “ Meaningful Segmentation of Offline Individual Handwritten Numeric Characters”, 2006 IEEE International Conference on Fuzzy Systems ,Vancouver, BC, Canada July 16-21, 2006.
- [11]Dr.Amitabh Wahi, Mr.Sundaramurthy.S,Poovizhi.P,”Recognition of Handwritten TamilCharacters using wavelet”,International Journal of Computer Science & Engineering Technology (IJCSET).